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February 3, 2005

International Searching Authority
European Patent Office
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Attn: J. Lapeyrere

Subject: International PCT Application No. PCT/CA2004/000514
International Filing Date: April 5, 2004
In the name of Pyrogenesis et al.
TWO-STAGE PLASMA PROCESS FOR CONVERTING WASTE INTO FUEL GAS AND APPARATUS THEREFOR

AMENDMENT UNDER ARTICLE 34 PCT

Sir:

This is responsive to the Written Opinion of September 3, 2004 issued in the above Application. This Amendment is being submitted before the expiry of the 22-month term from priority, i.e. before February 4, 2005.

Kindly amend the Application in the following respects:

Kindly substitute the enclosed new Claim pages 20 to 24 for corresponding Claim pages 20 to 24 at present on file.

REMARKS

Claims 1 to 25 remain in the Application.

In response to the Written Opinion, Applicants have amended the Application in order to overcome the Examiner's objections. Furthermore, Applicants have some comments which follow hereinbelow.

More particularly, Applicant has amended claim 1 in order to distinguish it over the art cited by the Examiner, namely D1 (WO 02/081909). In D1, Mitchell and Herrera use a second stage reactor mainly to enrich the heating value of the "plasma gas" so as to make it suitable for use in a gas turbine (page 7, lines 21 to 33). The reactor is used to convert CO2 and H2O to combustible H_2 and CO.

In the present invention, the purpose of the second stage of process Claim 1 (or of the secondary gasifier of apparatus Claim 20) is to "convert soot and complex organic molecules to CO, H_2 and CO_2" (page 13, lines 6 to 16). The carbon soot reacts with oxygen from air and steam to produce CO. Carbon soot is a solid and would be difficult to use as fuel in an engine. Complex organic molecules may not burn very efficiently in a relatively low temperature energy producing system such as an engine. What is meant by "completing the gasification of the organic components so as to convert them into fuel gas" in original Claim 1 is mainly that contaminants (soot and products of incomplete combustion) are converted to easier-to-burn H_2 and CO components, rather than to enrich the gas as in Mitchell et al's case.

Claim 1 has herein been amended to further define this innovative characteristic, using most of the limitations of original Claim 13 which had been indicated as allowable in the Written Opinion. Claim 13 has also been amended as a result of the changes made to Claim 1. Accordingly, independent Claim 1 as herein amended is believed to meet the requirements of both novelty and inventive step. Dependent Claims 2 to 19 should thus also now be allowable.

As to independent Claim 20, it has already been labeled as novel and non-obvious. Dependent Claims 21 to 25 are therefore also considered to meet the novelty and inventive step criteria.

Regarding Item VIII, Observation 4, Applicants consider that Claim 20 offers a sufficient balance of structural and functional limitations to be acceptable. Indeed, it not considered that Claim 20 relates "to a method of using the apparatus" as suggested in the Written Opinion, as the passage cited by the Examiner at the end of Observation 4 constitutes rather a structural limitation to which is associated a function (as commonly used in claim drafting). Furthermore, Claim 20 has already been indicated as reciting sufficient structural features to be novel and inventive over the found art, whereby it is considered that Claim 20 is acceptable in its current form.

Now turning to Observation 5 of Item VIII, Applicants has amended Claim 20 to overcome the objections raised by the Examiner to the three (3) passages appearing at the end of Observation 5. Again, with respect to some of these passages, it is considered that Claim 20 provides the required balance of structural and functional limitations to be allowable.

In summary, as a result of the present amendments to the Claims, the Application is considered to be in form for a fully positive IPER with respect to Claims 1 to 25. More particularly, independent Claims 1 and 20 present novelty and inventive ingenuity over the art of record, and the dependent claims are also considered clearly allowable over the prior art. Therefore, reconsideration of the Examiner's position in view of the amendments made herein and the above argumentation is respectfully requested.

Respectfully,

Michel Sofia

Goudreau Gage Dubuc

MS/ms/pc

Encl.: - Claim pages 20 to 24

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International Application No. PCT/ CA2004/000514

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New Claims	Action	Original Claims
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2 to 12	unchanged	2 to 12
13	amended	13
14 to 19	unchanged	14 to 19
20	amended	20
21 to 25	unchanged	21 to 25

CLAIMS

1. A two-stage plasma process for converting waste having organic and inorganic components into fuel gas, which comprises:

(a) in the first stage, vitrifying or melting the inorganic components of the waste and partially gasifying the organic components; and

(b) in the second stage, completing the gasification of the organic components so that gas from the first stage of the process entering the secondary gasifier is exposed to a high temperature such as to transform essentially all soot present in the gas to CO and to convert essentially all complex organic molecules to simpler molecules CO, CO_2 and H_2.

2. A process according to claim 1, in which a dust separation and removal step is provided between the two stages of the process.

3. A process according to claims 1 or 2, in which the fuel gas produced in the second stage is quenched and cleaned to make it suitable for use in a gas engine or turbine for production of electricity or in a gas burner for production of steam or in chemical synthesis reactions.

4. A process according to claims 1, 2 or 3, in which the first stage is carried out in a plasma arc furnace.

5. A process according to any one of claims 1 to 4, in which the second stage is carried out in a secondary gasifier using a plasma torch with addition of metered amounts of oxygen, air and/or steam.

6. A process according to claim 4, in which the plasma arc furnace is a refractory lined, enclosed furnace provided with at least one direct current graphite electrode adapted to generate a plasma arc to a bath of liquid inorganic material originating

from the waste itself and located at the bottom of the furnace.

7. A process according to claim 6, in which said liquid inorganic material comprises a slag layer which is maintained at a temperature of at least 1500°C.

8. A process according to claim 7, in which said liquid inorganic material further comprises a metal layer also maintained at a temperature of at least 1500°C and located under the slag layer.

9. A process according to claims 6, 7 or 8, in which the waste is introduced into the furnace on top of the liquid inorganic material and the organic component in the waste reacts with air, oxygen and/or steam supplied to the furnace in a predetermined amount adapted to achieve gasification of organic material in the waste into a primary synthesis gas containing CO, H_2, CO_2 and N_2 if the waste contains nitrogen or if air is added to the furnace, and also containing some soot and complex organic molecules.

10. A process according to claim 9, in which the organic material in the waste is so reacted as to form a layer of partially treated waste on top of the slag layer and fresh waste is introduced into the furnace on top of said partially treated waste layer which is maintained at a temperature of between 700 and 800°C and constitutes a cold top for the fresh waste added to the furnace.

11. A process according to claims 9 or 10, in which the primary synthesis gas is subjected to dust separation and removal in which dust particles larger than a predetermined size are separated and removed.

12. A process according to claim 11, in which the removed dust particles are recycled to the furnace.

13. A process according to claim 5, in which the secondary gasifier is equipped with a plasma torch fired eductor for exposing the gas from the first stage of the

process entering the secondary gasifier to a high temperature.

14. A process according to claim 13, in which the high temperature to which gas from the first stage is exposed in the secondary gasifier is between 900°C and 1300°C.

15. A process according to claim 14, in which the high temperature is achieved mainly by partial oxidation of the gas from the first stage by injection of predetermined amounts of air, oxygen and/or steam to the eductor, and the plasma torch provides only a small fraction of the energy required for maintaining said high temperature.

16. A process according to claims 13, 14 or 15, in which the fuel gas exiting the secondary gasifier is cooled down very rapidly to a temperature below 100°C so as to freeze the thermodynamic equilibrium of the fuel gas and avoid production of secondary pollutants.

17. A process according to claim 16, in which after cooling, the fuel gas is subjected to a final cleaning operation to remove any remaining contaminants.

18. A process according to any one of the preceding claims 1 to 16, in which the process is carried out under a negative pressure to preclude exit of toxic fumes or of flammable materials from any unit operations.

19. A process according to any one of the preceding claims 1 to 18, in which an oxygen starved environment in used in the process to preclude dioxin formation.

20. Apparatus for converting waste having organic and inorganic components into fuel gas, which includes:

(a) a primary gasifier comprising a refractory lined, enclosed plasma arc furnace provided with at least one graphite electrode; at least one inlet

for feeding waste into the furnace; means for feeding air, oxygen and/or steam in metered amounts into the furnace; and a gas take off port for primary synthesis gas produced in said primary gasifier; said primary gasifier being adapted to maintain layers of molten metal and molten slag at the bottom of the furnace and on top of the molten slag a layer of partially treated waste on top of which fresh waste is fed; and said at least one graphite electrode being adapted to generate a plasma arc to the molten slag present in the furnace during the operation; and

(b) a secondary gasifier to which the primary synthesis gas is fed, said secondary gasifier being equipped with a plasma-torch fired eductor adapted to expose the primary synthesis gas entering from the primary gasifier to a high temperature such as to transform essentially any soot present in said primary gas into CO and to convert essentially any complex organic molecule to simpler molecules CO, CO_2 and H_2; means for supplying metered amounts of air, oxygen and/or steam into the eductor; said eductor leading to an insulated chamber; and an outlet being provided in said chamber for the fuel gas resulting from the operation.

21. Apparatus according to claim 20, in which in the primary gasifier two graphite electrodes are used creating an arc between one electrode and the slag during the operation, and creating a second arc from the slag to the second electrode.

22. Apparatus according to claims 20 or 21, in which the eductor provided in the secondary gasifier is made of a high heat metal alloy or is refractory lined or water cooled, and is equipped with the plasma torch at its inlet.

23. Apparatus according to claims 20, 21 or 22, further comprising a dust separator between the primary gasifier and the secondary gasifier.

24. Apparatus according to any one of claims 20 to 23, further comprising a gas quenching and gas cleaning means following the secondary gasifier.

25. Apparatus according to any one of claims 20 to 24, further comprising an induced draft fan adapted to operate the apparatus under a negative pressure.